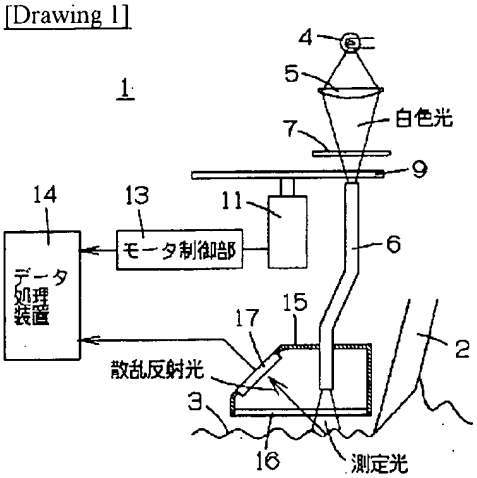
* NOTICES *

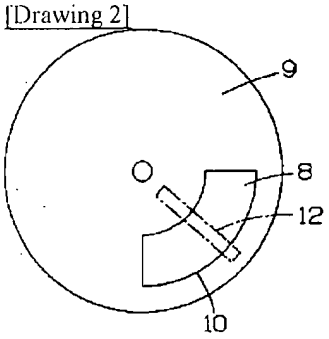


DRAWINGS

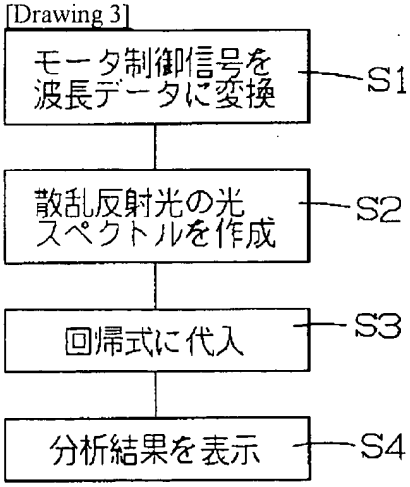
[Drawing 1]



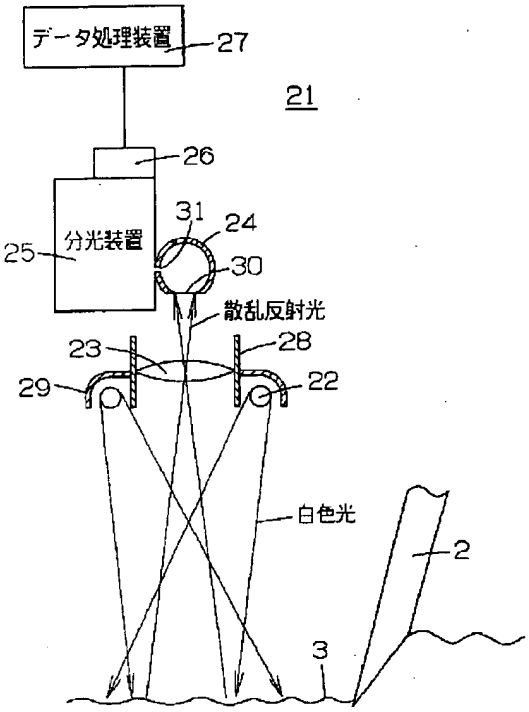

[Drawing 2]



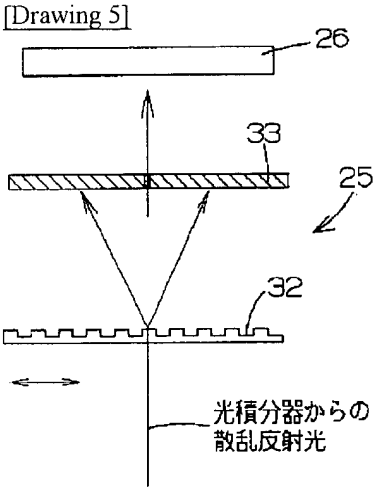

[Drawing 3]



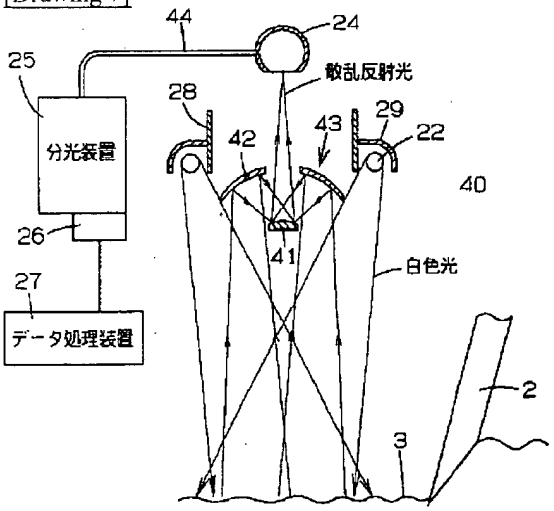

[Drawing 4]



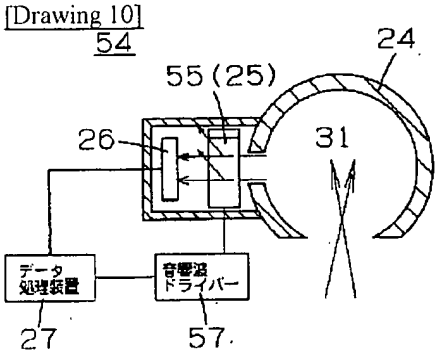

[Drawing 5]



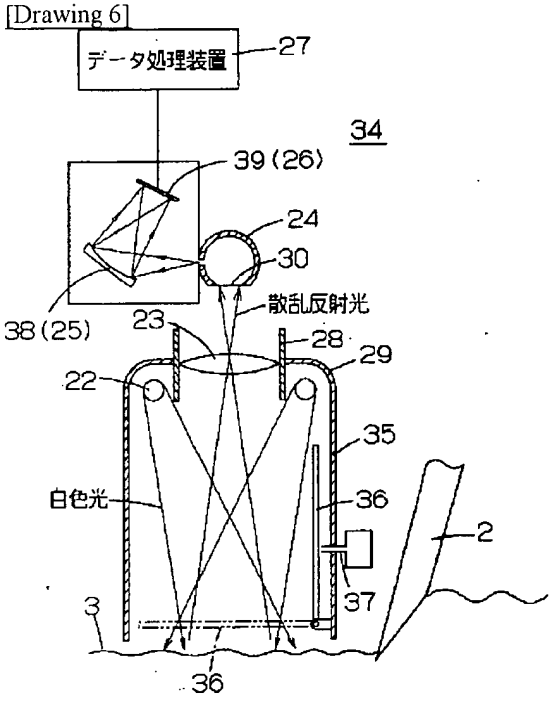

[Drawing 7]



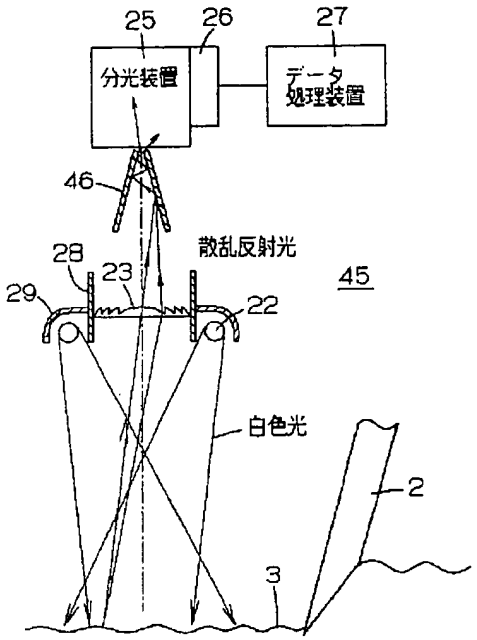
[Drawing 10]



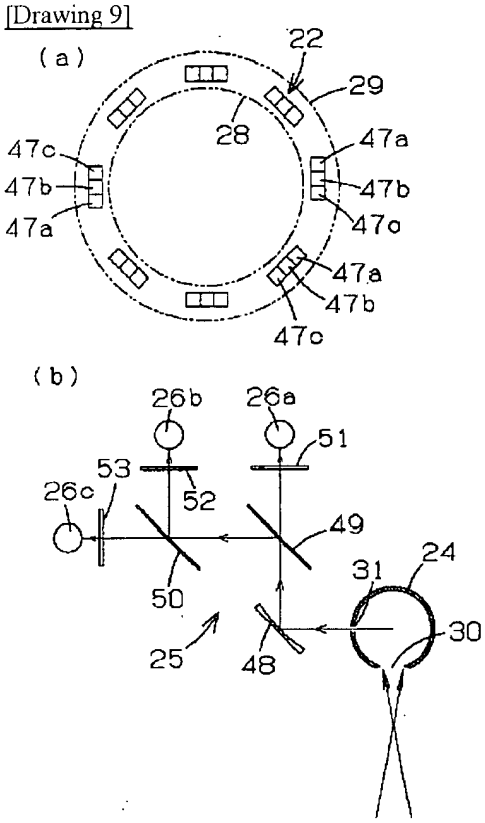

[Drawing 6]



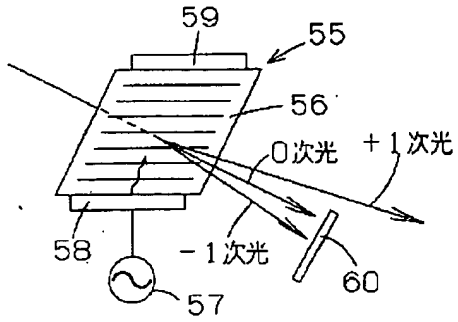

[Drawing 8]



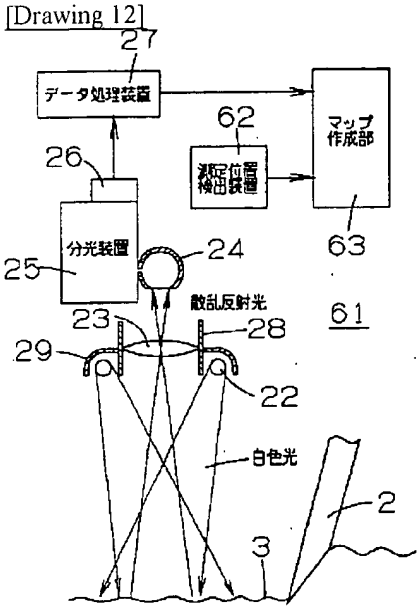

[Drawing 9]




[Drawing 11]




[Drawing 12]




[Translation done.]

* NOTICES *



## DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the schematic diagram showing the composition of conventional soil component analysis equipment.
[Drawing 2] It is the plan showing a filter disk same as the above.
[Drawing 3] It is the flow view showing the procedure in a data processor.
[Drawing 4] It is the schematic diagram showing the composition of the optical property measuring device of the soil by 1 operation gestalt of this invention.
[Drawing 5] the spectrum used for the optical property measuring device same as the above -- it is the principle view of equipment
[Drawing 6] It is the outline cross section in which showing the optical property measuring device of the soil by another operation gestalt of this invention and which was fractured in part.
[Drawing 7] It is the outline cross section in which showing the optical property measuring device of the soil by still more nearly another operation gestalt of this invention and which was fractured in part.
[Drawing 8] It is the outline cross section in which showing the optical property measuring device of the soil by still more nearly another operation gestalt of this invention and which was fractured in part.
[Drawing 9] drawing explaining the optical property measuring device of the soil by still more nearly another operation gestalt of this invention -- it is -- (a) -- a light source portion -- being shown -- (b) -- a spectrum -- equipment and a light sensitive cell are shown
[Drawing 10] It is the outline cross section showing the optical property measuring device of the soil by still more nearly another operation gestalt of this invention.
[Drawing 11] It is explanatory drawing showing the outline of an acoustooptics wavelength tuning element.
[Drawing 12] It is the outline cross section showing the optical property measuring device of the soil by still more nearly another operation gestalt of this invention.
[Description of Notations]
3 Soil Side
22 Light Source
24 Optical Integrating Sphere
25 Spectrum -- Equipment
26 Light Sensitive Cell
27 Data Processor
35 Shading Covering
36 Reference Board
47a, 47b, 47c Light emitting device
62 Measuring-Point Detection Equipment
63 Map Creation Section

[Translation done.]

## DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[The technical field to which invention belongs] this invention relates to the optical property measuring device of soil. Especially, the optical property of soil is measured and it is related with the optical property measuring device for analyzing the component of soil.
[0002]
[Description of the Prior Art] In order to make the yield of agricultural products increase, it is necessary to supply insufficiencies, such as an organic component in soil, and fertilizer, and to attain homogenization of the soil of the whole cultivated land. For that purpose, to analyze the component of soil, especially to carry out component analysis to real time is desired.
[0003] As soil component analysis equipment for that, the thing as shown in drawing 1 is known (Soil Organic Matter, CEC, and Moisture Sensing with a Portable NIR Spectrophotometer; K.A.Sudduth, J.W.Hummel: Transactions of the ASAE, 1993 Vol.36, 1571-1582). This soil component analysis equipment 1 is attached immediately after the plow 2 of a tractor posterior part, leads soil component analysis equipment 1 by tractor, moves in a field, analyzes the new soil side 3 exposed with the plow 2 with soil component analysis equipment 1, and measures the organic amount of resources, moisture, etc. in soil.
[0004] In this soil component analysis equipment 1, the white light emitted from the light source 4 is condensed by the one side end face of the bundle optical fiber 6 with a condenser lens 5. At this time, the white light condensed with the condenser lens 5 passes the slit board 7 and the wavelength-selection filter 8, and they carry out incidence to the end face of the bundle optical fiber 6. The wavelength-selection filter 8 is formed in the sector opening 10 of the filter disk 9 which carried out disc-like as shown in drawing 2 , and it is arranged so that selection wavelength (transmitted wave length) may change continuously along with the circumferencial direction of the filter disk 9. The rotation drive of the filter disk 9 is carried out by the rotary motor 11. Since the opening 12 of the slit board 7 is located long and slender in accordance with radial [ of the filter disk 9 ], if the filter disk 9 is rotating, the wavelength of the measuring beam of the monochrome which passes the slit board 7 and the wavelength-selection filter 8, and carries out incidence to the end face of the bundle optical fiber 6 will change continuously. Near-infrared light is used for the selection wavelength with the wavelength-selection filter 8 in many cases from the ultraviolet radiation of the range of 400-2500nm. Since rotation of the filter disk 9 by the rotary motor 11 is controlled by the motor control section 13 and the motor control signal is sent out from the motor control section 13 also to the data processor 14, in the data processor 14, the wavelength of the measuring beam (homogeneous light) by which incidence is carried out to the end face of the bundle optical fiber 6 is recognized. The other end of the bundle optical fiber 6 is led to ******** 15, and the measuring beam of the bundle optical fiber 6 which carried out incidence from the end face on the other hand spreads the bundle optical fiber 6 interior, it carries out outgoing radiation from an another side end face, it penetrates the quartz aperture 16 prepared in the base of ******** 15, and is irradiated to the new soil sides 3, such as cultivated land exposed by the plow 2.
[0005] In this way, scatter reflection of the measuring beam of the monochrome irradiated by the soil side 3 is carried out in respect of [ 3 ] soil, and scatter reflection light returns into ******** 15 again through the quartz aperture 16. A part of scatter reflection light which returned into ******** 15 is received by the light sensitive cell 17 prepared in about six bundle optical fiber of the ******** 15 interior. A light sensitive cell 17 transmits the light-receiving signal according to the scatter reflection luminous intensity which received light to a data processor 14.
[0006] Subsequently, a data processor 14 changes into the wavelength data of a measuring beam the motor control signal received from the motor control section 13, as shown in drawing 3 (S1). The optical spectrum of the scatter reflection light of the soil concerned is created from this wavelength data and the light-receiving signal in a light sensitive cell 17 (S2). By what (S3) the data about the optical spectral intensity of this scatter reflection light are substituted for the predetermined regression currently created beforehand for, the component of the soil concerned is analyzed and an analysis result is displayed on a display (not shown) (S4). In addition, regression is created in the procedure known as multivariate analysis.
[0007]
[Problem(s) to be Solved by the Invention] Conventional soil component analysis equipment received light by the light sensitive cell which has arranged the light which irradiated the measuring beam (homogeneous light) which changes from a bundle optical fiber continuously, and carried out scatter reflection to the new soil side exposed with the plow as mentioned above in respect of soil near the bundle optical fiber, and has acquired the optical spectrum of scatter reflection light from the light-receiving intensity.

[0008] However, generally the size of a particle, structure, and soil texture of soil are uneven, and the still smaller stone, foreign matter, etc. are mixing it in many cases. If such an ununiformity exists in soil, even if it irradiates a measuring beam at soil, the scatter reflection light is strongly weak in a specific direction, and it can be reflected partially, and neither with the direction of optical irradiation, nor the position of a light sensitive cell, it is not equally reflected in an omnidirection but it can analyze optical properties differ and ] a soil component correctly.
[0009] Moreover, since a soil side and the distance of a light sensitive cell were changed by movement of soil component analysis equipment and it changed the scatter reflection luminous intensity which the irradiation area irradiated by soil is changed and carries out incidence to a light sensitive cell from soil in moving soil component analysis equipment in a field and measuring the optical property of soil continuously, the accuracy of measurement of the optical property of soil was not able to fall, and a soil component was not able to be known correctly.
[0010] conventional soil component analysis equipment -- a soil side and the distance of a light sensitive cell -- being short (for example, about 15mm) -- the fall and dispersion of the accuracy of measurement by such cause were remarkable With conventional soil component analysis equipment, although what is necessary is just to have lengthened a soil side and distance with a light sensitive cell etc. in order to reduce the fall of the accuracy of measurement by change of a soil side and the distance of a light sensitive cell etc., since the scatter reflection luminous intensity which carries out incidence to a light sensitive cell decreased rapidly when distance of a soil side and a light sensitive cell was lengthened, the accuracy of measurement fell on the contrary, and it had become measurement impotentia.
[0011] The place which this invention is made in view of the fault of the above-mentioned conventional example, and is made into the purpose is to offer the optical property measuring device of the soil which cannot be based on dispersion in the irregularity of soil sides, such as a configuration of soil, and structure, soil texture, etc., can measure the optical property of soil with a sufficient precision, and can lengthen the optical distance of a soil side and a light sensitive cell, and can raise the accuracy of measurement.
[0012]
[Description of the Invention] The optical property measuring device of soil according to claim 1 The optical prehension section which catches and shuts up the light source which irradiates the latus measuring beam of a wavelength-range region, and the measuring beam by which scatter reflection was carried out in respect of soil towards a soil side, The condensing means which condenses the measuring beam by which scatter reflection was carried out in respect of soil, and is led to the aforementioned optical prehension circles, the means which carries out the spectrum of the light of the optical aforementioned prehension circles, and the above -- a spectrum -- it is characterized by having the light sensitive cell which receives the light in which the spectrum was carried out by the means, and a means to analyze the optical property of soil based on the measurement data of the aforementioned light sensitive cell
[0013] If it is in the optical property measuring device of this soil, from the light source, a measuring beam is irradiated towards a soil side, and with a condensing means, the measuring beam by which scatter reflection was carried out in respect of soil is brought together in optical prehension circles, and is caught. the spectrum after the scatter reflection light confined in optical prehension circles was reflected several times by optical prehension circles -- incidence is carried out to a means a spectrum -- the light by which the spectrum was carried out with the means is received by the light sensitive cell An analysis means analyzes the optical property of soil based on the measurement data (light income) of a light sensitive cell.
[0014] Therefore, according to this invention, the measuring beam by which scatter reflection was carried out in respect of soil is not directly received by the light sensitive cell. Since it can equalize by catching the scatter reflection light of the latus range which scatter reflection was carried out in respect of soil, and was emitted by the big solid angle to optical prehension circles and can detect by the light sensitive cell It cannot be based on the size of the configuration of soil, structure, soil texture, and a particle etc., but the optical property of soil original can be measured, and the reliability of measurement data can be raised.
[0015] Moreover, since the measuring beam by which scatter reflection was carried out in respect of soil was made to condense by the condensing means and it has led to optical prehension circles, even when the distance of a soil side and the optical prehension section is long, the measuring beams which carried out scatter reflection covering the latus area of a soil side can be collected, it can lead to ****** circles, and light-receiving intensity in a light sensitive cell can be made high. Furthermore, since the latus light of a wavelength-range region, for example, the white light, is irradiated in the soil side, irradiation intensity of a soil side can be enlarged and distance of a soil side and a light sensitive cell can be lengthened further.
[0016] Therefore, since a soil side and optical prehension ******** can lengthen distance with a light sensitive cell, even if it changes the distance of a soil side and a light sensitive cell by movement in a measurement area, the influence affect the optical property of soil decreases, the accuracy of measurement improves, and measurement dispersion is reduced.
[0017] The optical property measuring device of soil according to claim 2 The light source which irradiates the measuring beam which consists of two or more waves towards a soil side, and the optical prehension section which catches and shuts up the measuring beam by which scatter reflection was carried out in respect of soil, The condensing means which condenses the measuring beam by which scatter reflection was carried out in respect of soil, and is led to the aforementioned optical prehension circles, It is characterized by having a means which is different in the light of the optical aforementioned prehension circles to dissociate for every wavelength, the light sensitive cell which receives the light separated by the aforementioned separation means, and a means to analyze the optical property of soil based on the measurement data of the aforementioned light sensitive cell.
[0018] Although the light source differs from the optical property measuring device of a claim 1 at the point which irradiates two

or more waves of dispersed measuring beams, even if the optical property measuring device of this soil is in such an optical property measuring device, it does so the same operation effect as the optical property measuring device of a claim 1. That is, it cannot be based on the size of the configuration of soil, structure, soil texture, and a particle etc., but the optical property of soil original can be measured, and the reliability of measurement data can be raised. Moreover, since distance of a soil side and a light sensitive cell can be lengthened, even if it changes the distance of a soil side and a light sensitive cell by movement in a measurement area, the influence affect the optical property of soil decreases, the accuracy of measurement improves, and measurement dispersion is reduced.

[0019] As the above-mentioned optical prehension section, the cavity of the abbreviation spherical which has the inside of a high reflection factor like according to claim 3 can be used. the reflective direction [ in / a soil side / in the scatter reflection light which went into optical prehension circles from opening if it was in such the optical prehension section ] -- not depending -- the inside of the optical prehension section -- reflection -- repeating -- a spectrum -- since it goes into a means, in an optical electric eye, what equalized the luminous intensity reflected in each direction is detectable

[0020] Moreover, as the optical prehension section, like a publication, the area of the optical incidence side edge section is comparatively large to a claim 4, and an optical waveguide with a comparatively small area of the optical outgoing radiation side edge section can also be used for it. the reflective direction [ in / a soil side / in the scatter reflection light which went into optical prehension circles from the optical incidence side edge section if it was in such the optical prehension section ] -- not depending -- the inside of an optical waveguide -- reflection -- repeating -- the optical outgoing radiation side edge section -- concentrating -- a spectrum -- since it goes into a means, in an optical electric eye, what equalized the luminous intensity reflected in each direction is detectable

[0021] The embodiment according to claim 5 is characterized by covering between an opposite portion with a soil side, and soil sides by the shading member in the optical property measuring device of soil according to claim 1 or 2.

[0022] Like this embodiment, if between soil sides is covered by the shading member, the influence of disturbance light can be eliminated and sensitometry and reliability can be raised more.

[0023] The embodiment according to claim 6 is characterized by have arranged the reference board in the floodlighting direction from the aforementioned light source, or enabling it to remove to the position from which it separated from floodlighting in the optical property measuring device of soil according to claim 1 or 2.

[0024] this operative condition -- change of the optical property according to the instability (for example, sensitivity change of a light sensitive cell, fluctuation of the light source intensity of the light source, etc.) of optical system by arranging a reference board in the floodlighting direction of the light source, irradiating a measuring beam and acting to a reference board as the monitor of the optical property of a reference board, if it depends like -- an amendment -- things are made In addition, a soil side can be measured by moving a reference board to the position from which it separated from [ of the light source ] floodlighting.

[0025] The embodiment according to claim 7 is characterized by having a measuring-point metering device for pinpointing a measuring point in the optical property measuring device of soil according to claim 1 or 2.

[0026] According to this embodiment, since a measuring point can be pinpointed with a measuring-point metering device, measurement data and a measuring point can be associated. Therefore, measurement data, such as a soil component, can be analyzed synthetically in the whole measurement area. Moreover, since it is related with the measuring point when performing soil amelioration later based on measurement data, it can work easily.

[0027] Especially an embodiment according to claim 8 can create the property map of soil automatically from positional information and measurement data.

[0028]

[Embodiments of the Invention]

(1st operation gestalt) Drawing 4 is the schematic diagram showing the composition of the optical property measuring device 21 of the soil by 1 operation gestalt of this invention. this optical property measuring device 21 -- the light source 22, a condenser lens 23, the optical integrating sphere 24, and a spectrum -- it consists of equipment 25, a light sensitive cell 26, and a data processor 27 The light source 22 irradiates the white light to the soil side 3, and consists of a halogen lamp etc. The light source 22 is arranged annularly at the periphery section holding a condenser lens (single lens) 23 of a lens-barrel 28, and the upper surface [ of the light source 22 ] and periphery side is covered by the reflecting plate 29. In addition, between the lens-barrel 28 of a condenser lens 23, and the optical integrating sphere 24, although not illustrated, it is suitably shaded by the means so that disturbance light may not enter.

[0029] The white light (measuring beam) by which outgoing radiation was carried out from the light source 22 irradiates the soil side 3. This soil side 3 is a new soil side to which soil was scratched and was exposed with the plow 2, and is in the distance of the light source 22 and a condenser lens 23, and simultaneously regularity. Here, since it is made to irradiate the white light from the light source 22 in the soil side 3, irradiation intensity of the soil side 3 can be enlarged.

[0030] The optical integrating sphere 24 is carrying out the shape of an abbreviation spherical shell, and the light-receiving aperture 30 is formed in the inferior surface of tongue. The cavity used as the optical prehension section is established in the interior of the optical integrating sphere 24, and the internal surface is the optical diffusing surface (or mirror plane) whose reflection factor is about 100%. a part of this optical integrating sphere 24 -- an internal light -- a spectrum -- opening of the bore 31 for leading to equipment 25 is carried out

[0031] Here, the physical relationship of a condenser lens 23 and the optical integrating sphere 24 is made to carry out image formation of the image of the new soil side 3 exposed by the plow 2 to the light-receiving aperture 30 of the optical integrating

sphere 24 with a condenser lens 23. That is, it is the distance of a, a condenser lens 23, and the light-receiving aperture 30 about f, the soil side 3, and the distance of a condenser lens 23 in the focal distance of a condenser lens 23 b, then 1/(a)+(1/b) = (1/f) It is made to fill ****** mostly.

[0032] Therefore, if the distance between the soil side 3 and a condenser lens 23 is fully taken so that the relation of a>b may be filled even if the distance (a+b) of the soil side 3 and the optical integrating sphere 24 is long, the white light by which scatter reflection was carried out in the latus area of the soil side 3 will be brought together in the light-receiving aperture 30 of the optical integrating sphere 24 so that drawing 4 may also show. the spectrum from the bore 31 after repeating diffuse reflection, without absorbing the scatter reflection light which entered in the optical integrating sphere 24 inside the optical integrating sphere 24 -- it is led to equipment 25 therefore, the white light to which scatter reflection also of the distance detached building ****** from the soil side 3 with the optical big integrating sphere 24 was carried out in the latus (comparing with area of light-receiving aperture 30) area of the soil side 3 -- a spectrum -- it is led to equipment 25, as a result a light sensitive cell 26, and high sensitometry can be obtained

[0033] Even if it changes the distance of the soil side 3 and a light sensitive cell 26 by movement in a field since distance with the soil side 3, the optical integrating sphere 24, as a result a light sensitive cell 26 can be lengthened in this way if it is in the optical property measuring device 21 of the soil of this invention, the influence affect the optical property of soil decreases, the accuracy of measurement improves, and measurement dispersion is also reduced.

[0034] moreover, the scatter reflection light by which the scatter reflection light reflected in the various directions irregularly in respect of [ 3 ] soil and unevenly was also collected into the optical integrating sphere 24 from the light-receiving aperture 30, was equalized in the optical integrating-sphere 24 interior, and was equalized in each direction since image formation of the image of the soil side 3 was carried out to the light-receiving aperture 30 of the optical integrating sphere 24 with the condenser lens 23 -- the spectrum from a bore 31 -- it is sent out to equipment 25

[0035] But, if the inclination and irregularity of the front face of soil differ from the size of a soil particle etc., dispersion will produce the luminous intensity with the same property (component) of soil in which scatter reflection is carried out by the distribution from the soil side 3 by the direction to detect. Light is not directly received by equipment 25 or the light sensitive cell 26. however, the measuring beam by which scatter reflection was carried out in respect of [ 3 ] soil like the optical property measuring device 21 of this invention -- a spectrum -- catching the scatter reflection light of the latus range which scatter reflection was carried out in respect of [ 3 ] soil, and was emitted by the big solid angle in the optical integrating sphere 24 -- equalizing -- a spectrum, if light is received by equipment 25 or the light sensitive cell 26 It cannot be based on the size of the configuration of soil, structure, soil texture, and a particle etc., but the optical property of soil original can be measured, and the reliability of measurement data can be raised.

[0036] a spectrum -- equipment 25 takes out the light of specific wavelength alternatively among the scatter reflection light drawn from the bore 31 of the optical integrating sphere 24, and scans the selection wavelength by constant speed from predetermined minimum wavelength to the longest wavelength such a spectrum -- what consists of a filter disk 9 equipped with the wavelength-selection filter (interference filter) 8 which was stated, for example in the conventional example ( drawing 2 ) as equipment 25, and a slit board 7 can be used

[0037] or the diffraction grating 32 and the slit board 33 to which the chromatism of the white light is carried out as shown in drawing 5 -- a spectrum -- constituting equipment 25 and moving a diffraction grating 32 or the slit board 33 -- a spectrum -- the thing to which it was made to change continuously the wavelength of the measuring beam by which outgoing radiation is carried out from equipment 25 may be used

[0038] As a light sensitive cell 26, semiconductor photo detectors, silicon photodiodes, etc., such as InGaAs, PbS, and PbSe, can be used.

[0039] In this way, light-receiving of the scatter reflection light by which the spectrum was carried out by the light sensitive cell 26 sends a light-receiving signal to a data processor 27 from a light sensitive cell 26. on the other hand -- a data processor 27 -- a light sensitive cell 26 -- going -- a spectrum -- the signal which shows the wavelength of a measuring beam from equipment 25 is also received Since the absorption of light of specific wavelength occurs by the component of soil when a measuring beam is reflected in respect of [ 3 ] soil, a characteristic optical spectrum (absorption spectrum) is shown according to the component of soil. a spectrum -- if the optical intensity which is receiving light by the light sensitive cell 26 is detected changing continuously the wavelength taken out with a spectrum with equipment 25, since the optical spectrum of scatter reflection light is acquired, the component of the soil concerned can be analyzed by analyzing this by the data processor 27

[0040] (2nd operation gestalt) Drawing 6 is the cross section which the optical property measuring device 34 of the soil by another operation gestalt of this invention fractured the part. If it is in this operation gestalt, in order to prevent that disturbance light goes into a condenser lens 23, and the accuracy of measurement falls, as it extended from the reflecting plate 29, the shading covering 35 is hung to near the soil side 3. Moreover, the reference board 36 is formed under the light source 22 and the condenser lens 23, and the reference board 36 pivots an end in the shading covering 35, stands the reference board 36, opens the inferior surface of tongue of the shading covering 35, topples the reference board 36, and it is made to close the inferior surface of tongue of the shading covering 35. As a reference board 36, ceramic boards, such as an alumina, etc. can be used and, as for the both sides, the reflection factor has become about 100%.

[0041] According to this operation gestalt, by toppling the reference board 36, closing the inferior surface of tongue of the shading covering 35, irradiating the white light and acting to the reference board 36 as the monitor of the optical spectrum of the reference board 36, change of the optical property by the instability (for example, sensitivity change of a light sensitive cell 26,

fluctuation of light source intensity, etc.) of optical system can be detected, and it can be used for an amendment of measurement data. In addition, the soil side 3 can be measured by standing the reference board 36 and opening the inferior surface of tongue of the shading covering 35.

[0042] Moreover, the high-pressure air injection nozzle 37 is formed in the reference board 36 which the shading covering 35 stood, and the part which counters, and when the reference board 36 is opened, it can be made to carry out by spraying high-pressure air on the reference board 36 from the high-pressure air injection nozzle 37 cleaning removal of soil, mud, etc. adhering to the reference board 36. In addition, the field to clean is the upper surface side of the reference board 36 which irradiates the white light.

[0043] this operation gestalt -- a spectrum -- the reflected type diffraction grating 38 is used as equipment 25, and the diode array 39 is used as a light sensitive cell 26 since each wavelength can be received with each diode element of a diode array 39 according to such composition -- a spectrum -- the structure for carrying out the scan of the wavelength of equipment becomes unnecessary, an optical predetermined spectrum can be measured simultaneously and the use efficiency of light becomes good

[0044] (3rd operation gestalt) Drawing 7 is the schematic diagram showing the composition of the optical property measuring device 40 of the soil by still more nearly another operation gestalt of this invention. if it is in this optical property measuring device 40 -- as a condensing means -- a convex mirror 41 and a hole -- the refraction reflecting mirror 43 which consists of a vacancy concave mirror 42 is used According to such composition, compared with an actual distance of the soil side 3 to the optical integrating sphere 24, the optical distance from the soil side 3 to the optical integrating sphere 24 can be lengthened, and the optical property measuring device 40 can be miniaturized.

[0045] moreover, the optical integrating sphere 24 and a spectrum -- since it has joined together optically using an optical fiber 44 (or optical fiber bundle), without linking equipment 25 directly -- a spectrum -- the flexibility of arrangement of equipment 25 grade can miniaturize increase and the optical property measuring device 40

[0046] (4th operation gestalt) Drawing 8 is the schematic diagram showing the composition of the optical property measuring device 45 of the soil by still more nearly another operation gestalt of this invention. If it is in this optical property measuring device 45, the Fresnel lens (diffraction lens) is used as a condenser lens 23. moreover, the optical integrating sphere 24 -- replacing with -- the optical waveguide 46 of a taper configuration -- using -- **** -- a side with the big size of an end face (optical incidence side edge side) -- a condenser lens 23 side -- turning -- a side with the small size of an end face (optical outgoing radiation side edge side) -- a spectrum -- equipment 25 is arranged

[0047] Although drawing 8 shows the optical waveguide 46 from which the inner skin of the barrel which carried out the shape of a truncated cone turned into a mirror plane, you may use the optical waveguide 46 formed in the shape of a truncated cone with the transparent resin with a big refractive index.

[0048] even if it is in this operation gestalt, while the scatter reflection light which the white light image formation had been made to be carried out in the incidence side edge side of an optical waveguide 46, and the image of the soil side 3 carried out [ the white light ] scatter reflection in respect of the soil of latus area with the condenser lens 23 was brought together in the optical waveguide 46, and the reflected light of each dispersion direction was also brought together in the optical waveguide 46, and went into the optical waveguide 46 reflects the inside of an optical waveguide 46 -- a spectrum -- incidence is carried out

[0049] Therefore, it cannot be based on the irregularity of the soil side 3 etc., but the equalized scatter reflection light can be led to a spectroscope, and the accuracy of measurement can be stabilized.

[0050] (5th operation gestalt) the schematic diagram and drawing 9 (b) which show the light source 22 of the optical property measuring device of the soil according [ drawing 9 (a) ] to still more nearly another operation gestalt of this invention -- a spectrum -- it is drawing showing the composition of equipment (wavelength decollator) 25 and a light sensitive cell 26 This is an operation gestalt which does not use the white light as a light source light. as shown in drawing 9 (a), it has different luminescence wavelength -- two or more -- the light emitting devices 47a and 47b, such as three light emitting diodes (Light Emitting Diode) and semiconductor laser elements (LD), and 47c1 -- it carries out for constructing, arranges around a lens-barrel 28, and the light source 22 is constituted Therefore, with this operation gestalt, the light of three wavelength lambda1, lambda2, and lambda3 is irradiated by the soil side 3 from the light source 22.

[0051] on the other hand -- a spectrum -- equipment 25 with the collimation mirror 48 which collimates the scatter reflection light which carried out incidence from the optical integrating sphere 24, as shown in drawing 9 (b) Only the light of wavelength lambda 1 Only the light of the dichroic mirror 49 made to penetrate and wavelength lambda 3 It consists of the dichroic mirror 50 made to penetrate, the band pass filter 51 which makes only the light of wavelength lambda 1 penetrate, a band pass filter 52 which makes only the light of wavelength lambda 2 penetrate, and a band pass filter 53 which makes only the light of wavelength lambda 3 penetrate. Light-sensitive-cell 26a for receiving the light of wavelength lambda 1 is arranged at the transparency side of a band pass filter 51. Light-sensitive-cell 26b for receiving the light of wavelength lambda 2 is arranged at the transparency side of a band pass filter 52, and light-sensitive-cell 26c for receiving the light of wavelength lambda 3 is arranged at the transparency side of a band pass filter 53.

[0052] (6th operation gestalt) Drawing 10 is the schematic diagram showing the composition by the side of light-receiving of the optical property measuring device 54 of the soil by still more nearly another operation gestalt of this invention. the thing aiming at measurement with this highly precise operation gestalt -- it is -- a spectrum -- as equipment 25, the acoustooptics wavelength tuning element (it is called AOTF below Acoust-Optic Tunable Filter; ) 55 is used

[0053] In AOTF55, it is the band pass filter which separates the homogeneous light from the white light and carries out the scan of the wavelength electrically, and does not have a movable portion. As AOTF55 consists of acoustooptics crystal [thing [ for

example, ] which acoustic wave [ of a tellurium-dioxide (TeO2) crystal ] and travelling direction of light intersect] 56, and an acoustic wave driver 57 and it is shown in drawing 11 The transducer (Acoustic Transducer) 58 and the absorber (Acoustic Absorber) 59 are stuck on the side where a crystal 56 counters. If the electrical signal of RF frequency is impressed to a transducer 58 from the acoustic wave driver 57, when an acoustic wave will pass through under a crystal 56 from a transducer 58 to an absorber 59 and an acoustic wave will pass, distortion produced during a crystal 56 carries out work like a grating. If the white light is irradiated by this AOTF55, only the homogeneous light can penetrate and, moreover, this transmitted wave length can control by RF frequency. Although the half-value width of this transmitted wave length is based also on wavelength, to the order which is 1nm, it can be narrowed and is [ permeability is also high and ] possible a maximum of 98%. However, since the transmitted light is divided into the zero-order diffracted light and the primary [ **] diffracted light, as shown in drawing 11 , the zero-order diffracted light and the -primary diffracted light (or +primary diffracted light) are cut with a shield 60 so that a light sensitive cell 26 may not be reached.

[0054] in this way, the spectrum which consists of AOTF55 -- the homogeneous light which penetrated equipment 25 is irradiated by the light sensitive cell 26, and the scan of the irradiation wavelength is carried out by the acoustic wave driver 57 from minimum wavelength to the longest wavelength (for example, 400nm - 2500nm) a spectrum -- if AOTF55 is used as equipment 25, since there is no movable portion and wavelength can be controlled electrically, wavelength scan speed is accelerable Moreover, the photo detector with sufficient responsibility like an InGaAs element is used for the light sensitive cell 26.

[0055] On the other hand, a data processor 27 has received the light-receiving signal from the light sensitive cell 26 while detecting irradiation wavelength with the signal from the acoustic wave driver 57. It is desirable that a data processor 27 uses a Fourier transform type spectroscopy as a method which searches for an optical spectrum from a light-receiving signal, and the method using an interferogram (interferogram) is desirable especially. Here, an interferogram means change [ of the interference light intensity which carried out measurement documentation as a function of the optical path difference x when changing the optical path difference of a bundle-of-rays interferometer ] F (x), and an optical spectrum is searched for by carrying out the inverse Fourier transform of the interferogram F (x). Since these interferograms, a Fourier transform type spectroscopy, etc. are conventional methods for searching for an optical spectrum, detailed explanation is omitted.

[0056] Moreover, this optical property measuring device 54 is equipped with the reference board 36 of an amendment sake for a time change of the light source 22, and searches for an optical-absorption spectrum in the following sequence. First, the reference board 36 is taken down, the inferior surface of tongue of the shading covering 35 is closed, the scan of the irradiation wavelength of a measuring beam is carried out in the state, and the diffuse reflection on-the-strength spectrum R of the reference board 36 (lambda) is measured. Subsequently, the reference board 36 is raised, the inferior surface of tongue of the shading covering 35 is opened, the scan of the irradiation wavelength of a measuring beam is carried out again, and the diffuse reflection on-the-strength spectrum S of soil (lambda) is measured. And absorption intensity Abs(lambda) =log[R(lambda)/S(lambda)]
The optical-absorption spectrum of shell soil is searched for.

[0057] the optical property measuring device 54 of this operation gestalt -- ** -- a spectrum -- using electrically AOTF55 in which a high-speed highly precise wavelength scan is possible as equipment 25, and ** reference board 36 -- using -- the fluctuation of the light source 22 etc. -- an amendment -- highly precise soil component analysis is made possible by searching for an optical spectrum by things and ** interferogram etc.

[0058] (7th operation gestalt) Drawing 12 is the schematic diagram showing the composition of the optical property measuring device 61 of the soil by still more nearly another operation gestalt of this invention. This optical property measuring device 61 is equipped with measuring-point detection equipment 62. The thing of a method which detects a position can be used by supervising the move direction and movement magnitude as measuring-point detection equipment 62 using a positioning system (GPS; Grobal Positioning System), a gyroscope sensor, etc. using artificial sanitation. The positional information detected by measuring-point detection equipment 62 is sent to the map creation section. In the map creation section 63, the information on the soil component obtained from the data processor 27 and the measuring-point information acquired from measuring-point detection equipment 62 are associated and accumulated, and the soil component map in the whole measurement area is created automatically. The created soil map is saved at a record medium, is displayed on a display, or is outputted from a printer etc.

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[Translation done.]